MAT482 Topics in Mathematics: Math Models

"If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is."
--John von Neumann

Course Synopsis
This course is designed to provide upper level undergraduates and beginning graduate students with an understanding of how mathematical modeling is the link between mathematics and the rest of the world. Nature is highly complex and mathematical modeling can help to unlock the secrets to problems in engineering, physics, astronomy, biology, medicine, chemistry, economics, and the social sciences among other fields. Modeling is a way of structuring questions about the world so that mathematical techniques may provide insight. It is as much an art as a science.

This course will cover a broad spectrum of modeling approaches including optimization, dynamical systems, and stochastic processes. Some topics covered include sensitivity analysis, model robustness, multi-variable optimization, linear programming, operations research, compartment models, neuronal models, bifurcation theory, renewal theory, Markov chains, queuing theory, diffusion, and some stochastic models in biology. Regular computer lab sessions will be used to teach visualization and simulation of the mathematical models studied.

A substantial component of the course grade will be a modeling project with a student-selected topic. Evaluation of the project will be based on a research report and a presentation. Regular written homework and two midterm exams will also be part of the course grade.

Instructor
Dr. Adam R. Stinchcombe
Office: BA6224
E-mail: stinch@math.toronto.edu
Office Hours: TBD or by appointment
Course Location
TBD

Course Website
URL TBD. The website will be used to post announcements, as well as to assign and collect homework and lab reports.

Prerequisites
In order to be successful in this course, it will be necessary to have a solid foundation in ordinary differential equations (MAT244) and linear algebra (MAT223,MAT224). A course in probability or some experience with Matlab or Python would be helpful.

Project
Students should work in teams of two or three, preferably, although you can discuss with me the possibility of individual projects or larger groups. For the project, you will give a 15 minute in-class presentation during the last two weeks of the course and submit a research report. Attendance at the presentations of other groups will form part of your grade. Start thinking early about topics that interest you and locate research materials on that topic. Be prepared to submit a project outline in mid-March.

For the project, you can develop a novel mathematical model related to your topic, or provide extensions or new applications for an existing mathematical model. It will not be sufficient to study an existing model and present already reported results for the model; there must be a novel component to your project.

Project presentations will take place in class on the last three lecture dates. The final project report is due at 5:00pm on the last day of classes.

Exams
There will be two in-class midterm exams (dates TBD). Please contact me as soon as possible if you have an unavoidable conflict with these dates. This course does not have a final exam.

Computer Labs
There will be regular computer labs, only on Fridays. We will make considerable use of Matlab.

Homework
There will be approximately three written homework assignments and seven lab reports. Please submit a PDF on the course website on the due date before 11:59pm. Late homework will not be accepted unless permission is given ahead of time.
**Grading Scheme**

Course grades will be determined from the following components:

- written homework and lab reports 30%
- two midterm exams 2 x 15%
- project report and presentation 40%

**Textbook**

Required: "Mathematical Modeling" by Mark M. Meerschaert (4th ed.)


**Testing Accommodations**

If you think you need an accommodation for a disability, please let me know as soon as possible. Please provide appropriate documentation to me at least two weeks prior to the need for a test accommodation.

**Code of Behaviour / Plagiarism**

The University of Toronto treats cases of academic misconduct very seriously. Academic integrity is a fundamental value of learning and scholarship at the UofT. Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that your UofT degree is valued and respected as a true signifier of your individual academic achievement.

The University of Toronto's [Code of Behaviour on Academic Matters](#) outlines the behaviours that constitute academic misconduct, the processes for addressing academic offences, and the penalties that may be imposed. You are expected to be familiar with the contents of this document. Potential offences include, but are not limited to:

- In papers and assignments:
  - Using someone else's ideas or words without appropriate acknowledgement.
  - Submitting your own work in more than one course without the permission of the instructor.
  - Making up sources or facts.
  - Obtaining or providing unauthorized assistance on any assignment (this includes working in groups on assignments that are supposed to be individual work).
• On tests and exams:
  ◦ Using or possessing any unauthorized aid, including a cell phone.
  ◦ Looking at someone else's answers.
  ◦ Letting someone else look at your answers.
  ◦ Misrepresenting your identity.
  ◦ Submitting an altered test for re-grading.

• Misrepresentation:
  ◦ Falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes.
  ◦ Falsifying institutional documents or grades.

All suspected cases of academic dishonesty will be investigated following the procedures outlined in the Code of Behaviour on Academic Matters. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact an instructor. If you have questions about appropriate research and citation methods, you are expected to seek out additional information from an instructor or other available campus resources like the College Writing Centres, Academic Success Centre, and U of T Writing Website.

Students must not distribute, in any form, any course materials (tests, labs, etc) to any third parties.

Accessibility

Students with diverse learning styles and needs are welcome in this course. Please feel free to approach the instructors or Accessibility Services so we can assist you in achieving academic success in this course.